RHIC Polarimetry: Run11 summary & Run12 plans

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RHIC Retreat
21.07.2011

Run11 brief summary:
- Improvements Run9→Run11
- Detector performance
- Carbon targets, lifetime
- Results

Run12 plans:
- Detectors: types, calibration tools
- Targets: ongoing tests
- Stability issues: target orientation
- General issues
- Longer term prospects

Note:
Emphasis here on pC;
H-jet progress, plans
as noted

Run9→11 changes

in ~increasing order of significance

Si detectors:

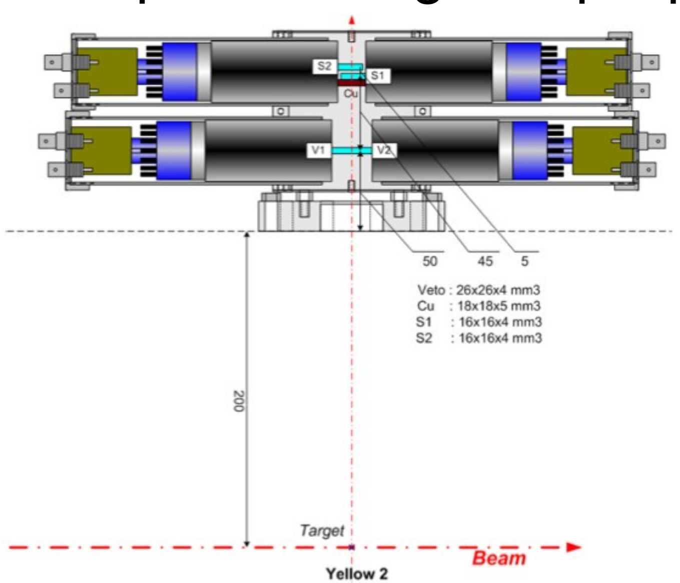
- Continued program testing commercial (Hamamatsu) det.
  - 20/24 pC det.: from BNL instrumentation group
  - 4/24 pC det. from Hamamatsu; smaller area, rate (~¼)
- H-jet: 1 bad det. replaced

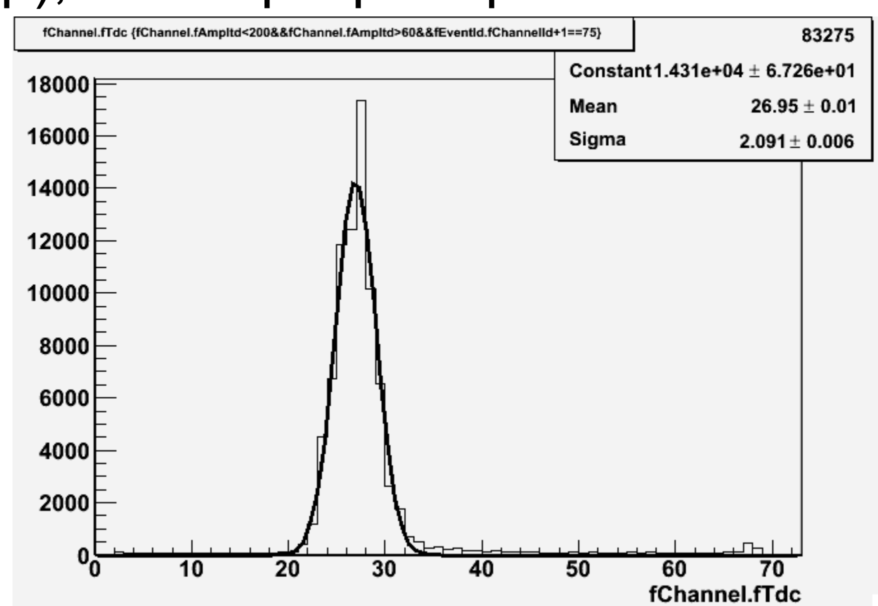
DAQ:

- Attempted ½ pC readout in tunnel (shorter cables, cleaner signals)
- Electronics quickly failed (rad. damage); relocated outside
- Downstream pC not available earliest Run11

t0 monitors:

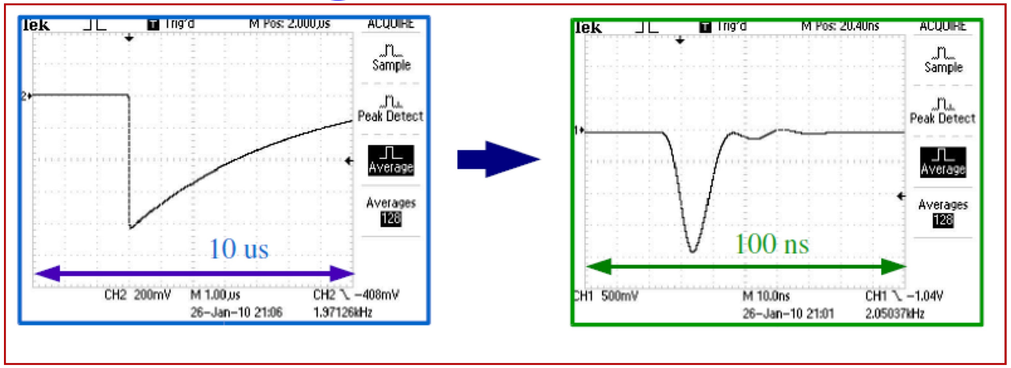
- Scint. pair viewing one pC polar. (Y2Up); detect pC prompts





Run9→11 changes

- Through Run9, rate effects observed: pileup/signal loss, calibration, ...
- Run11: replaced preamps
  Q→I sensitive; pulse 10's nS→~10 nS
- Test pulse all preamps ~500 Hz
- Monitor pulse rate, amplitude:

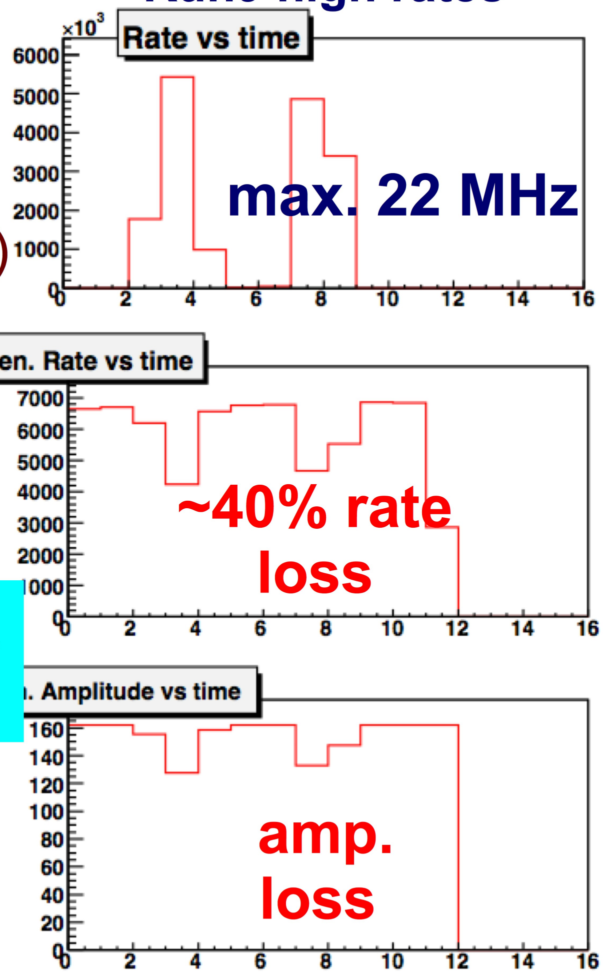


Run9 high rates

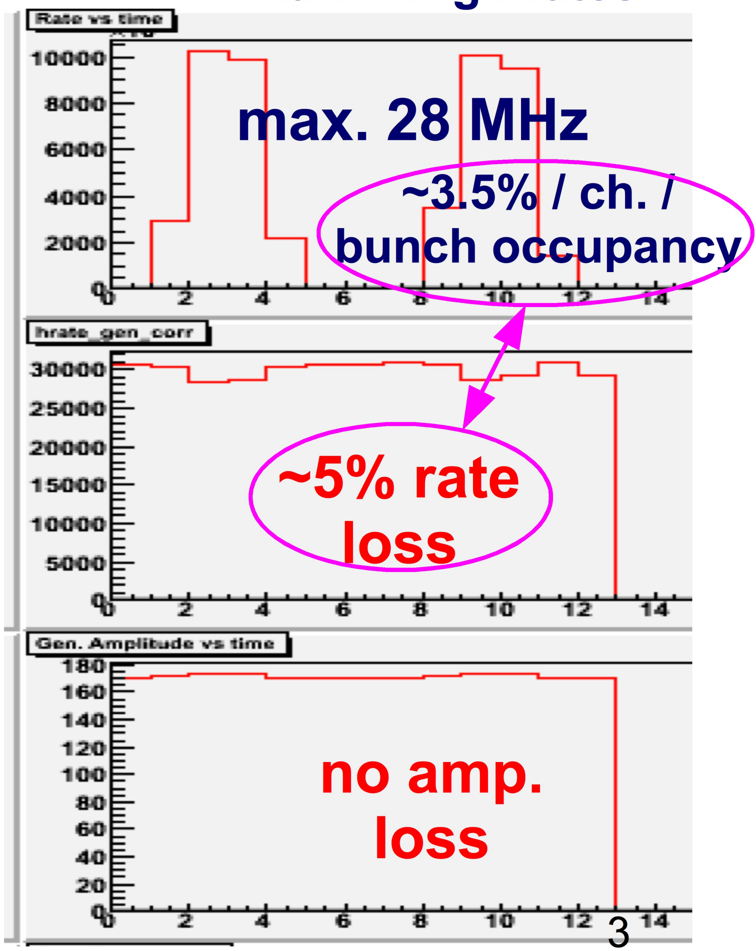
total pC rate in Si (for 72 ch.)

test pulse rate

test pulse amplitude



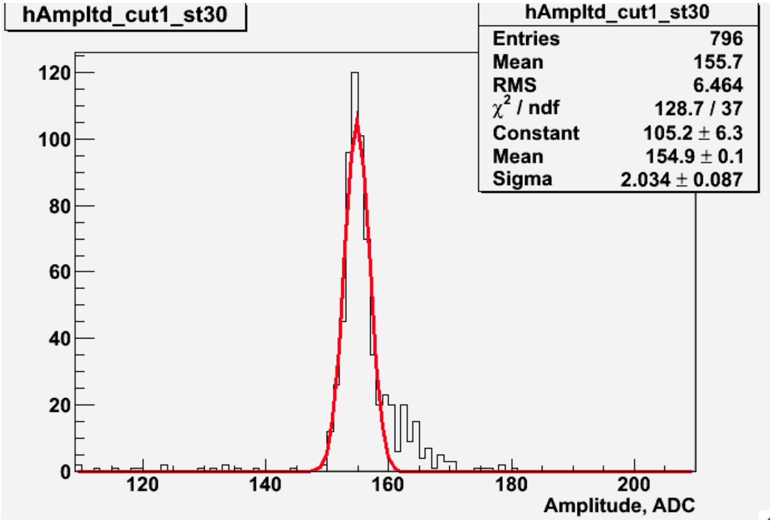
Run11 high rates



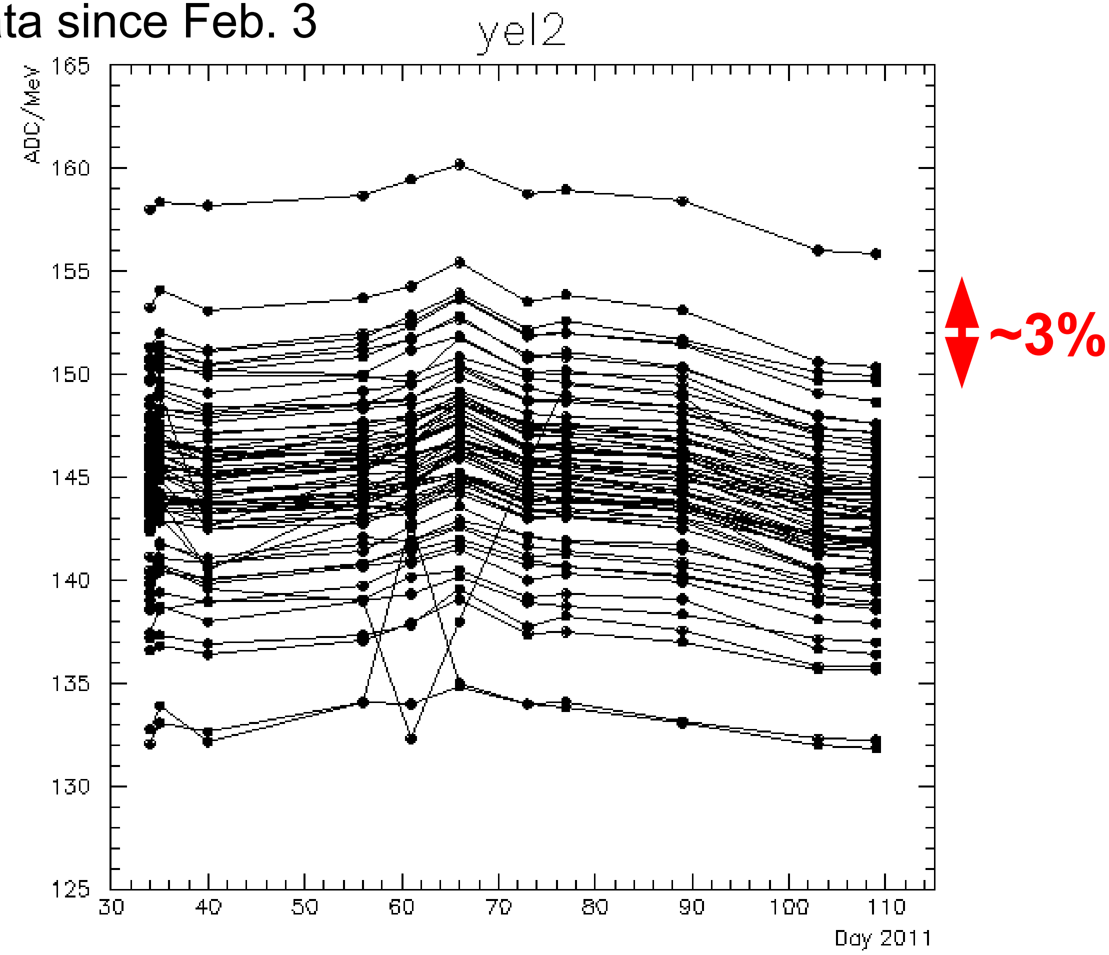
Run11: No significant rate effects observed

Det. performance: α source calib.

- ^{241}Am α source: Si det. gain calib., monitor
- Low rate; long runs maint. days:



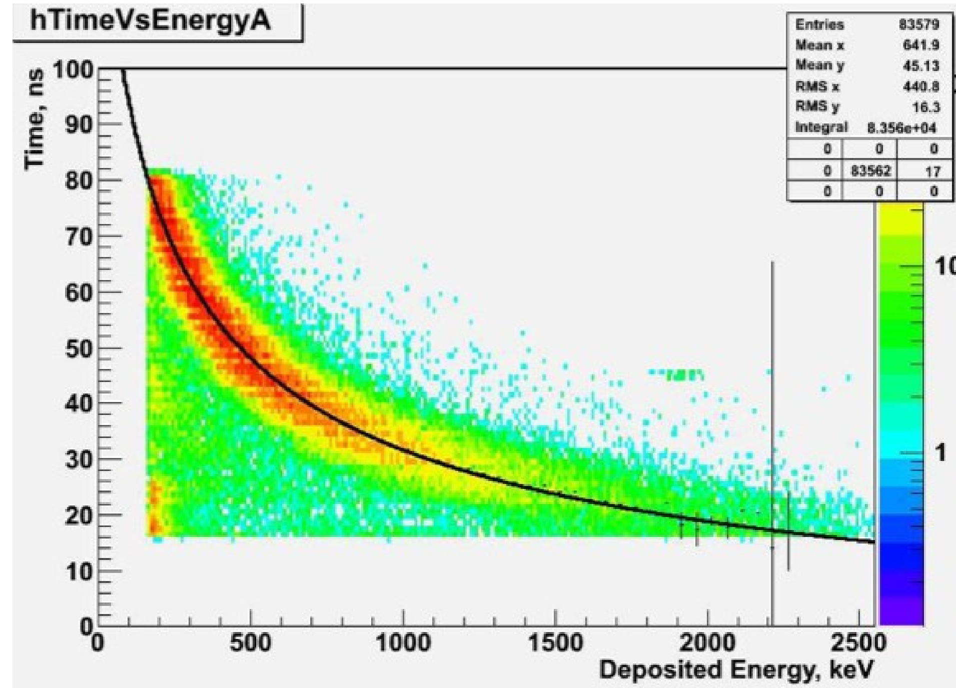
data since Feb. 3



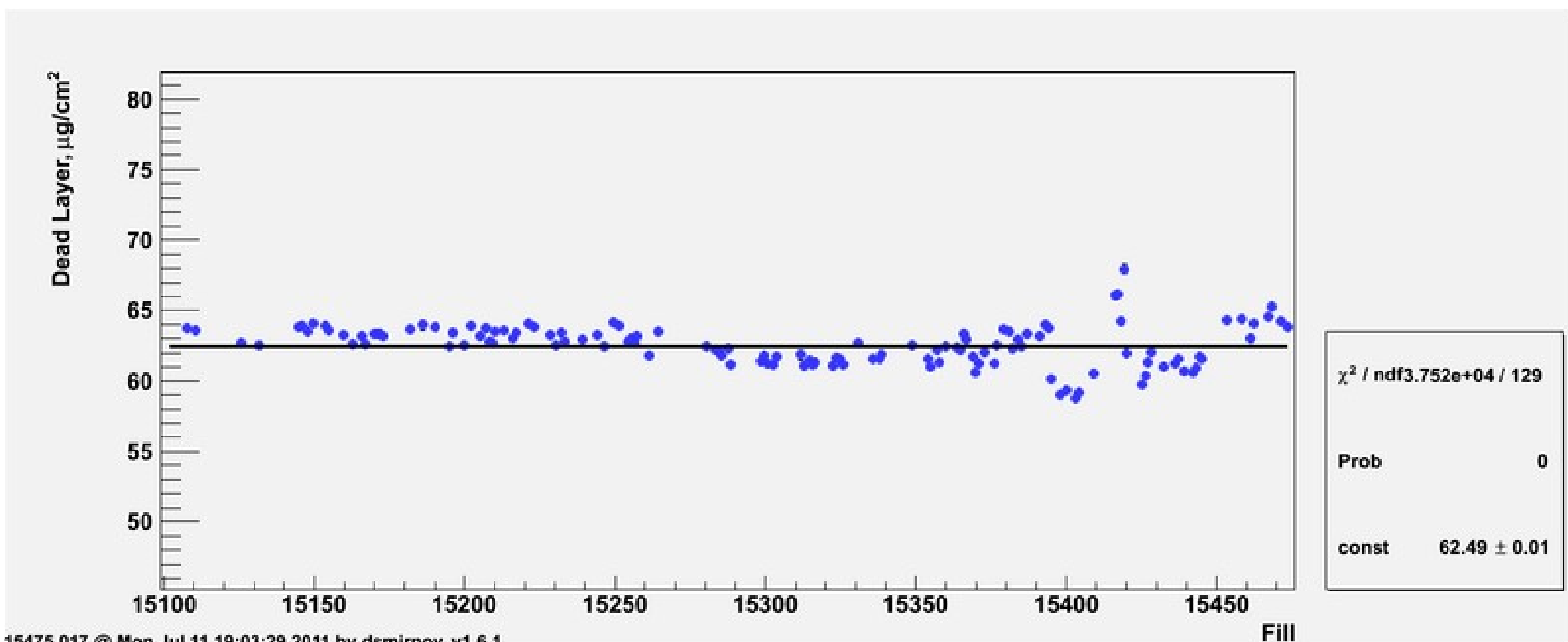
- Largely stable gains ~couple-%
- Few isolated chan. wandered; no obvious cause

Si detector stability

- pC 'banana plot': TOF vs. k.e.:
- From fit k.e. $T=½M_C v^2$, 2-param:
  - dead layer: E loss near Si surface
  - t_0 readout time offset

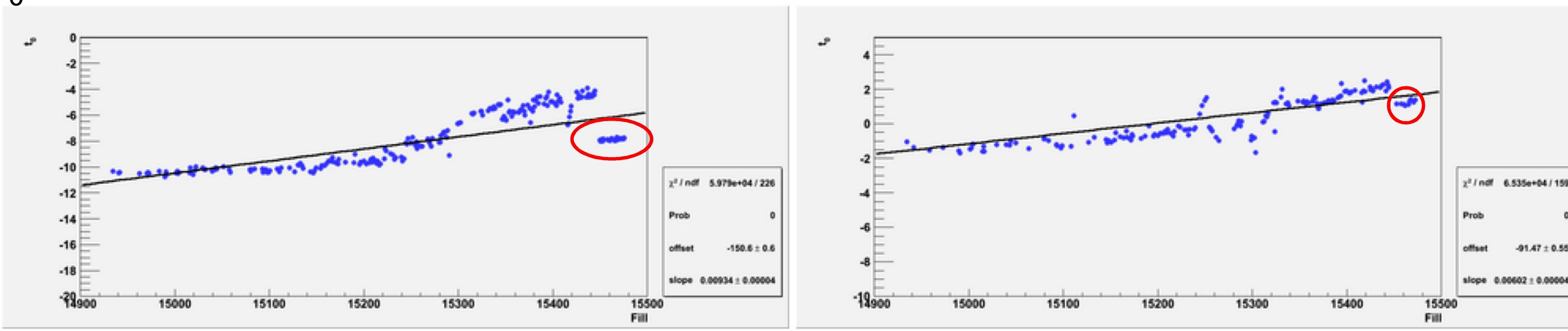


- Here dead layer vs. fill:
- Much more stable; previous years garbled by rate effects



t_0 stability

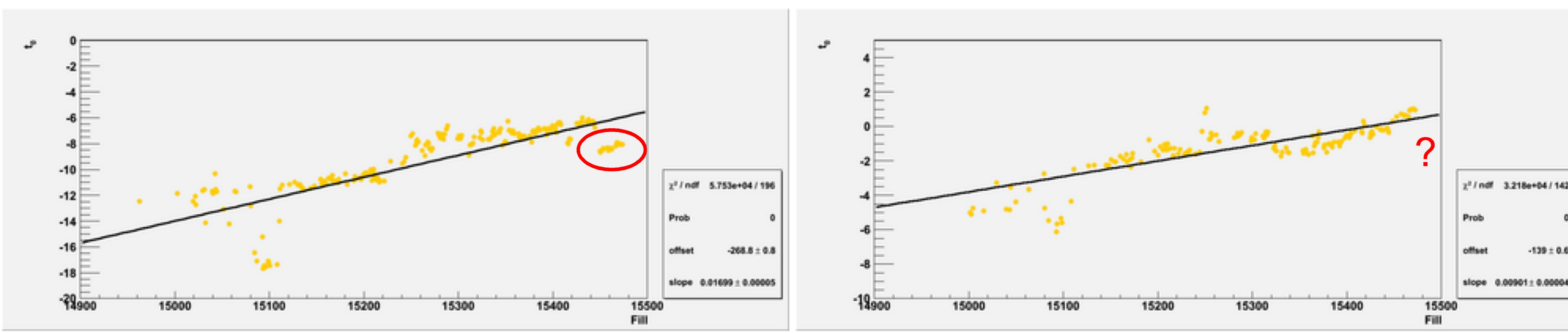
- t_0's slow drift few nS over Run11 apparent:



Beam energy 24 GeV   Beam energy 250 GeV

Blue-1 Upstream

- Jump few nS near end, 9 MHz RF lost; expected?

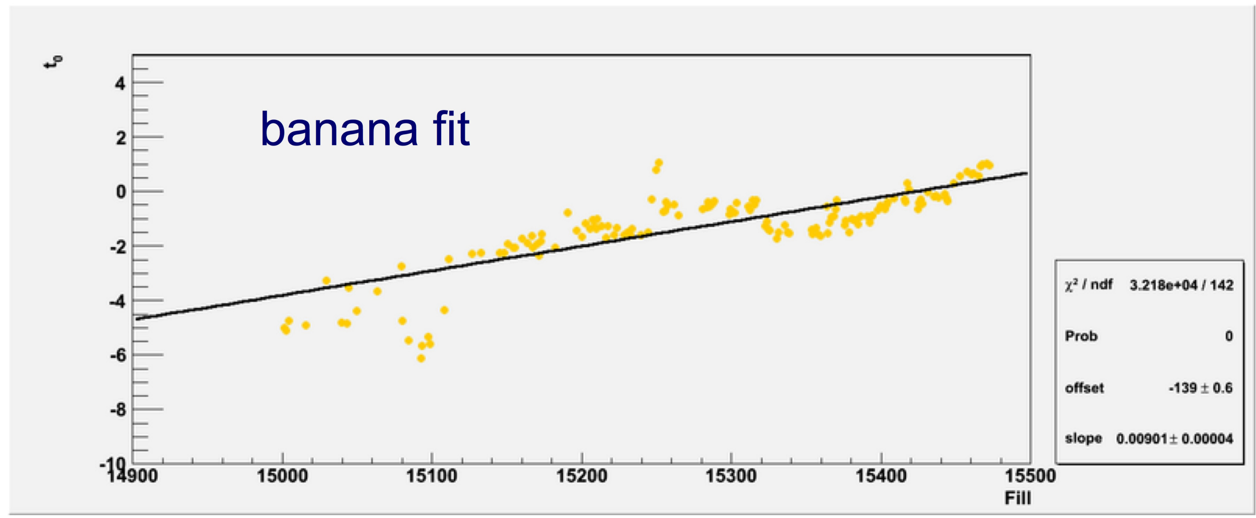


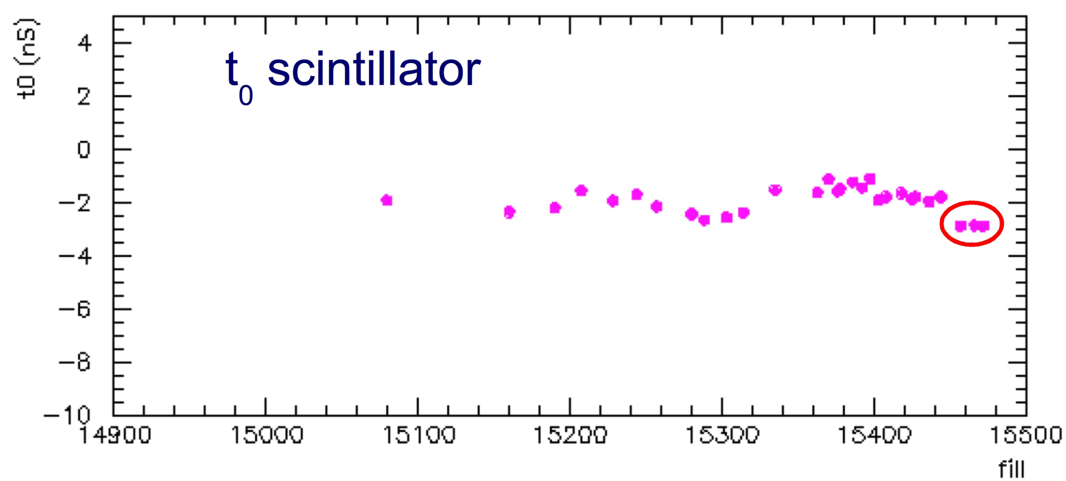
Beam energy 24 GeV   Beam energy 250 GeV

Yellow-2 Upstream

t_0 stability

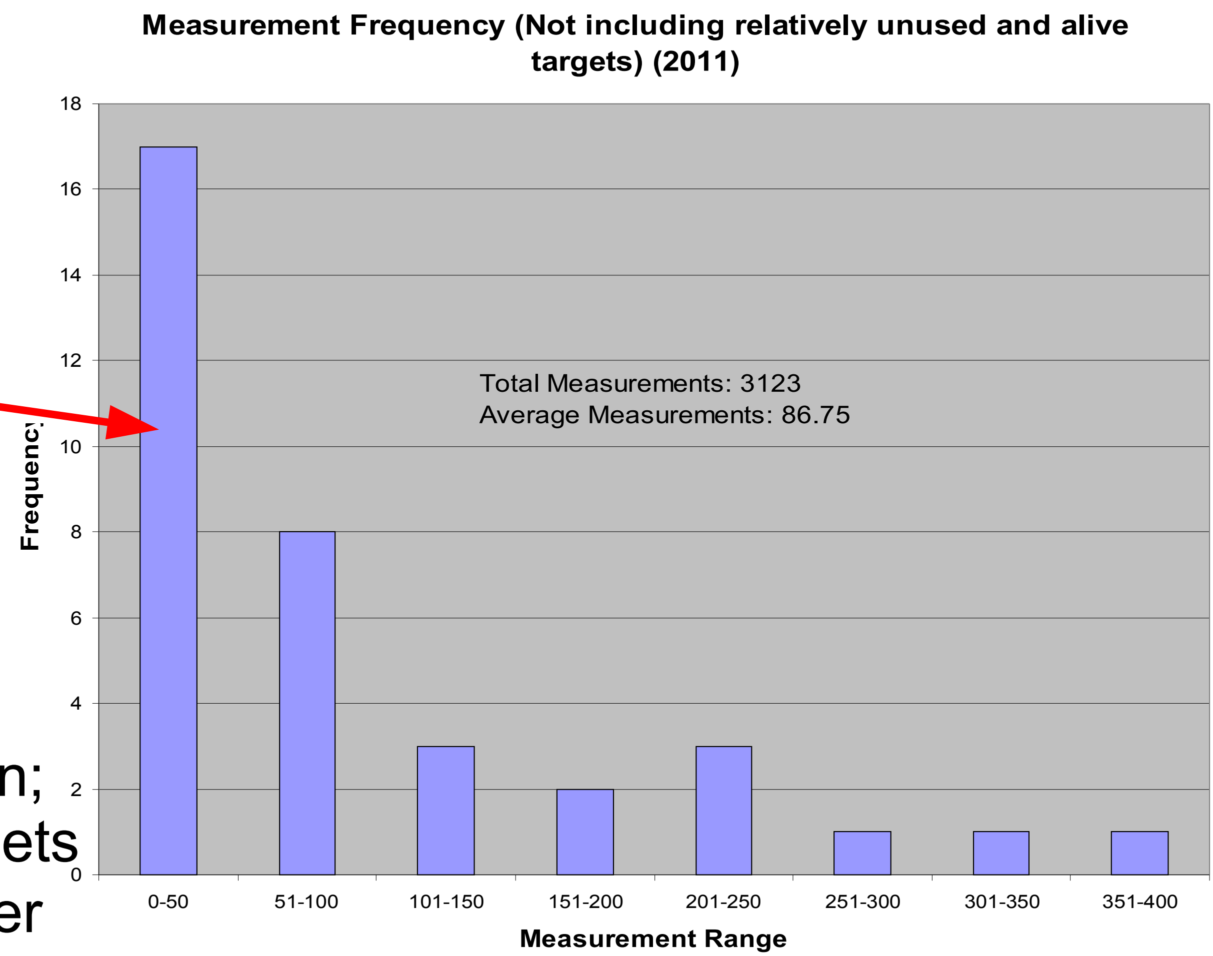
- Can check Yel-Up t_0 with t_0 prompt scintillator
- Drift not apparent in scint., seems more stable; need to check all runs
- Jump near end in scint., not in banana fit
- In banana fit, params. $t_0 \leftrightarrow$ deal layer correlated
- t_0 scintillator may disentangle, work in progress...





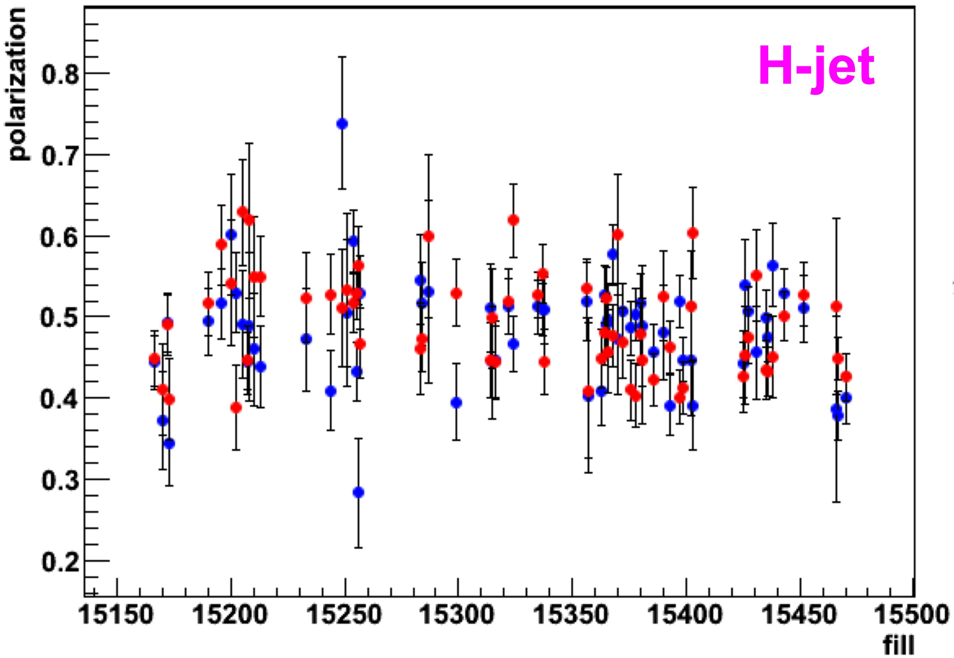
Target survival

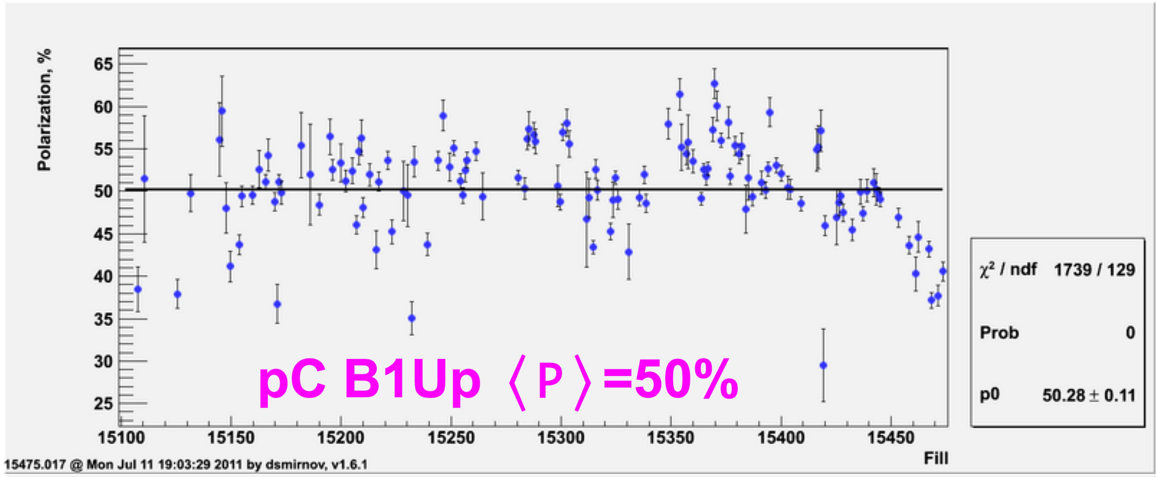
- Run11 high target mortality:
  36/48 targets lost
  (Run9 28/48 lost)
- Distribution of measurements before target lost:
  large infant mortality
- Other first observations:
  - loose targets survive better
  - targets get looser with use
- Also: our nominal target size is ~7μ wide across beam, ~25 nm thick in beam direction; had also 8 2×, 2 4× thick targets
  $\Rightarrow$ thicker targets survive better
- Further studies ongoing (more later)

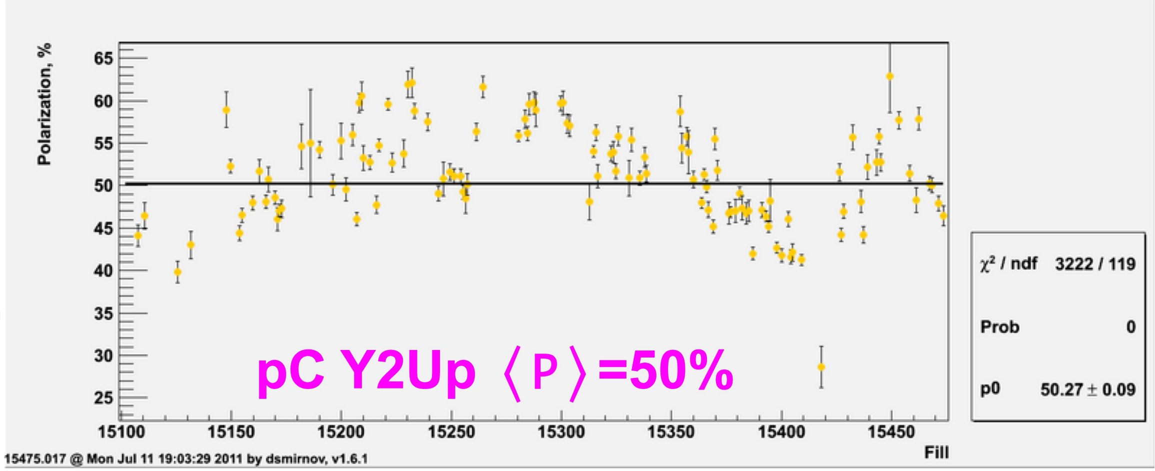


Run11 results

- The main results: Blu/Yel polarization vs. fill







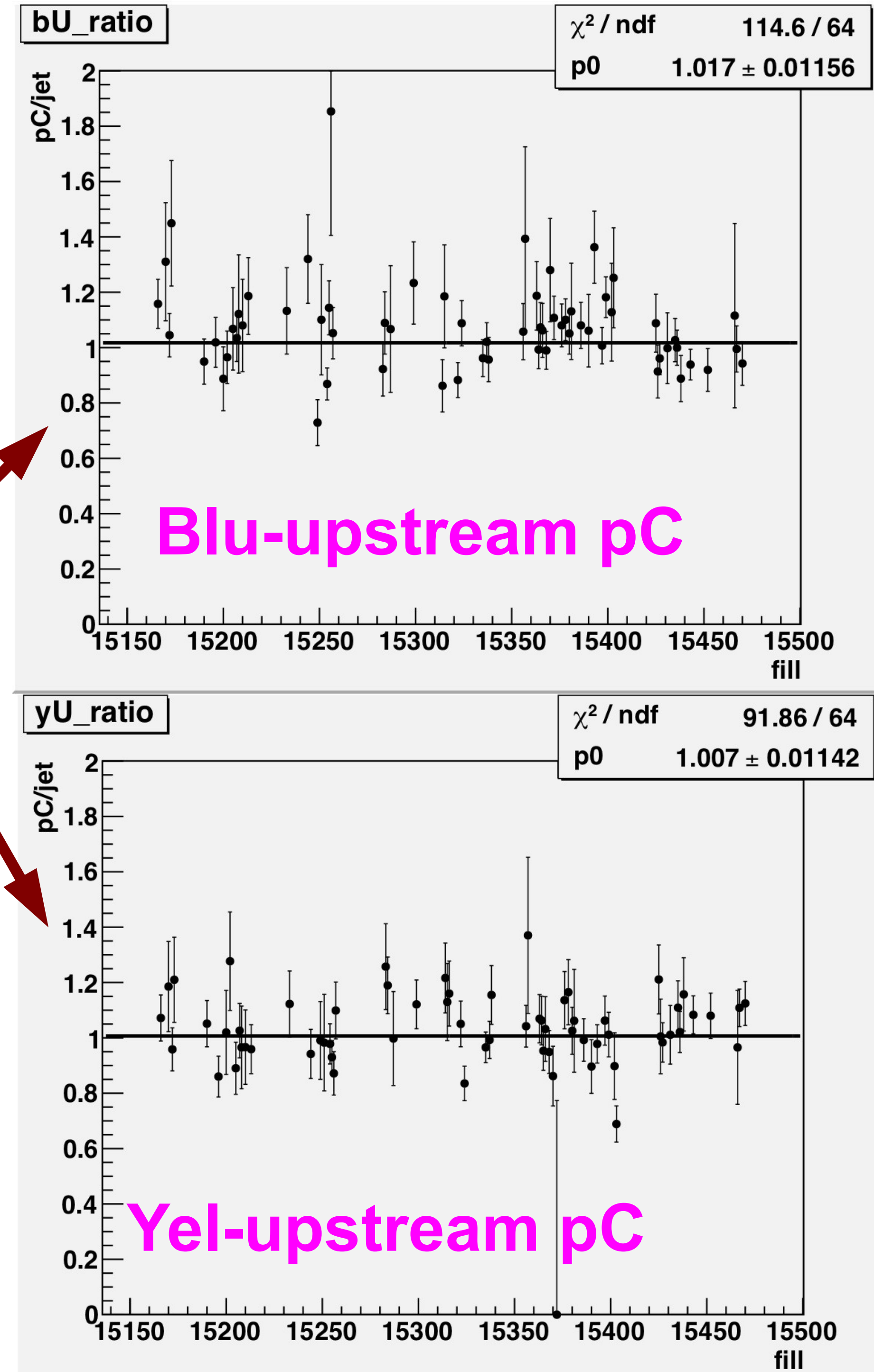
- More polarimetry results already discussed various forums:
  e.g. Haixin yesterday polar.profiles, polar. lifetime, ...
- Here focus on internal polarimeter stability checks ↘

pC/H-jet normalization

- Normalize each pC polar. to H-jet values for ring blue/yellow
  $\Rightarrow$ effective A_N each polar.

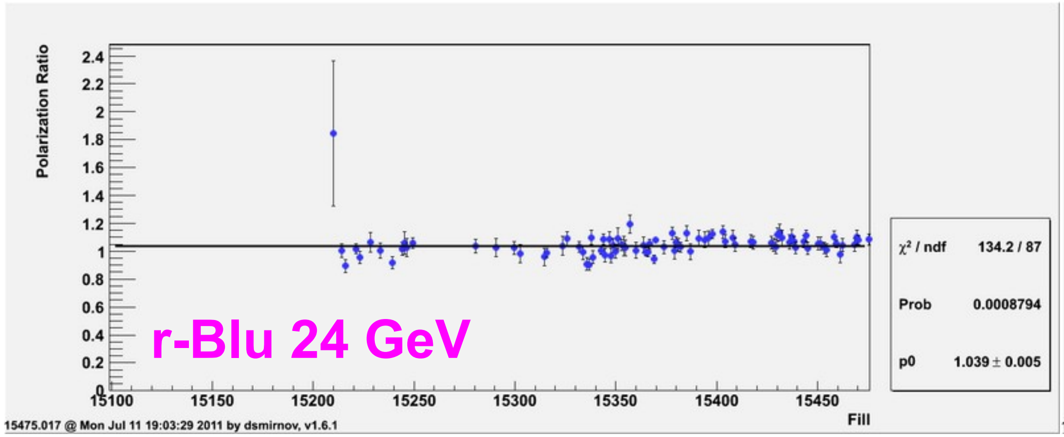
- pC/H-jet ratio vs. RHIC store (compared to mean, absolute value arbitrary)
- Uncert. dominantly H-jet stat.

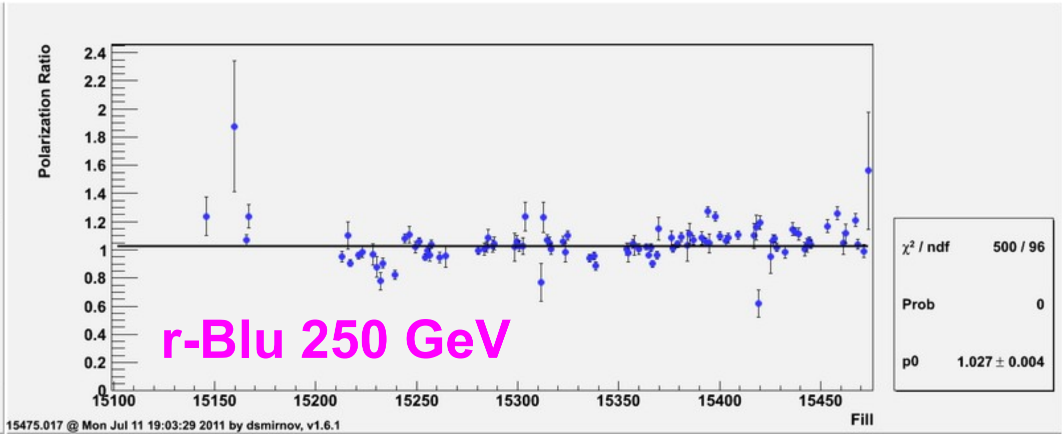
- Should be constant in time
- Fluctuations (other than stat.) indicative of sys. variations

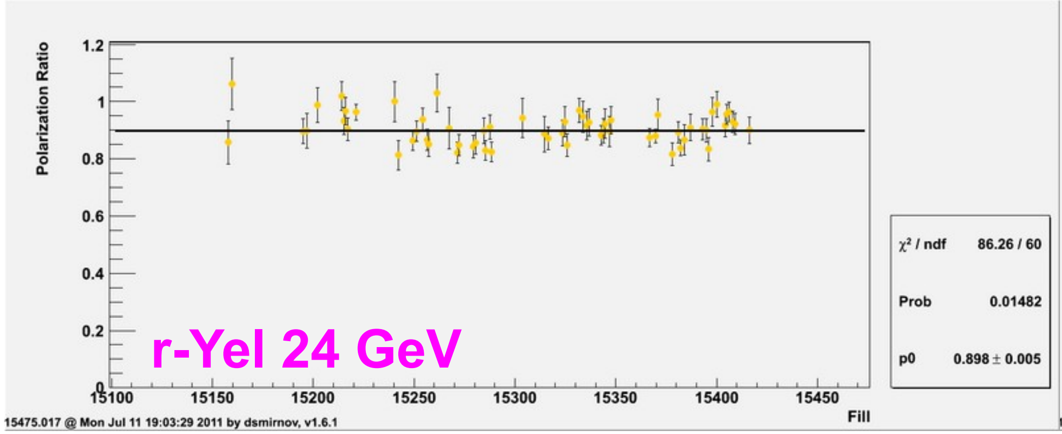


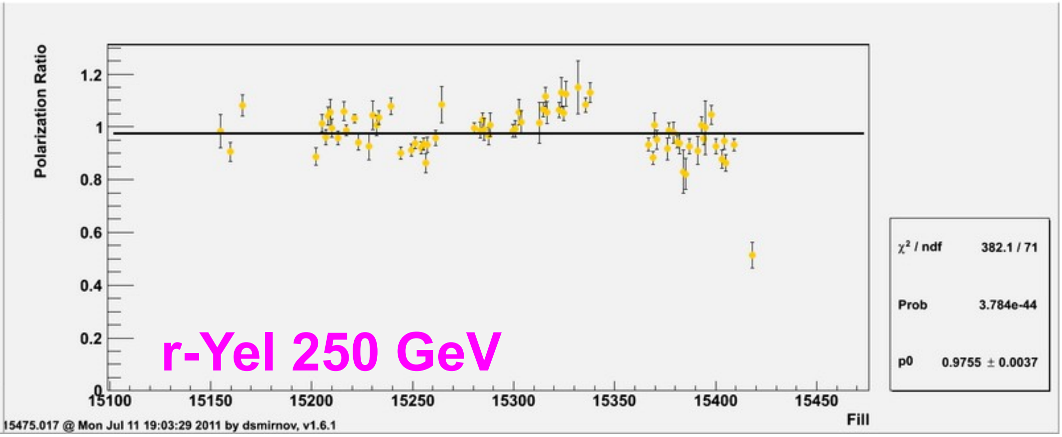
Polarization ratio Up/Dn vs. fill

- Final pC/H-jet normalization <u>not</u> applied in 24 GeV plots
- Check ratio constant in time:









- Deviations from constant $\Rightarrow$ measure of run-to-run systematics

Run 12 plans: detectors

pC

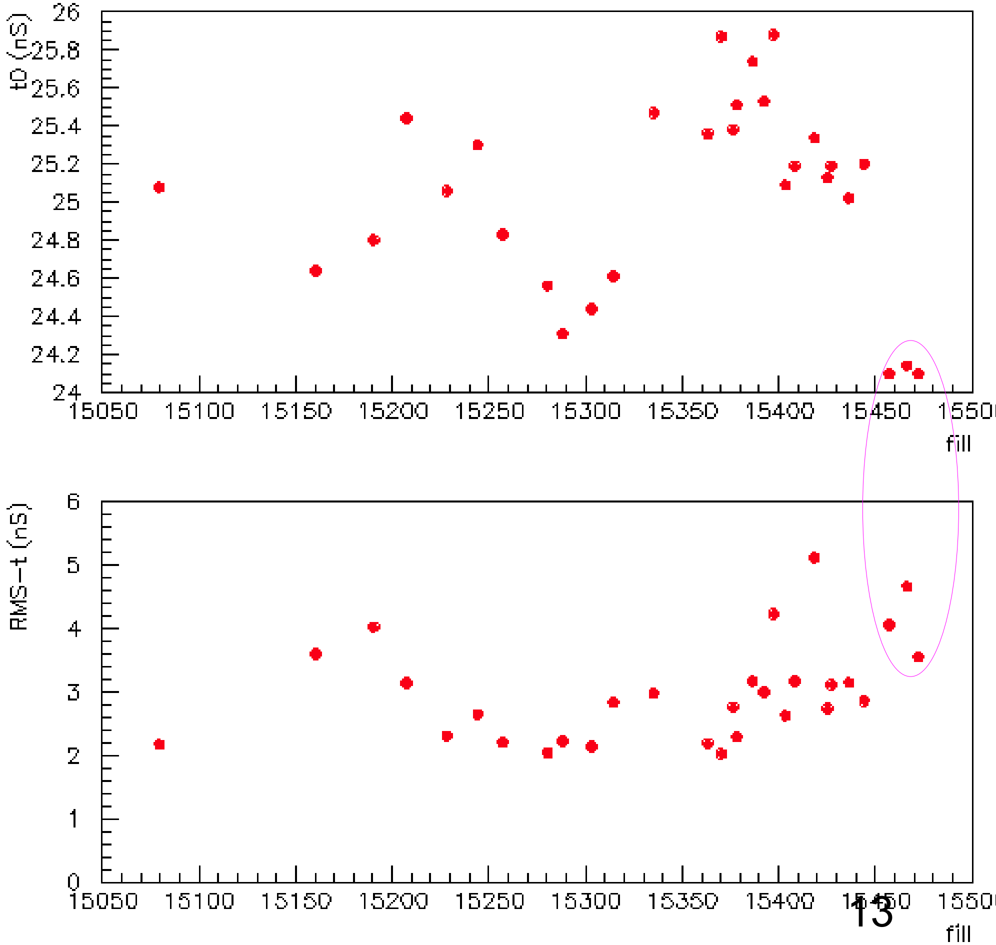
- As shown Si detectors stable & no degradation:
  α-calibration, t_0 & dead layer from 'banana fits'
- Will replace one (BNL) detector drawing varying high bias current
- Else will continue with same BNL, Hamamatsu detectors as Run11

H-jet

- Continue as Run11 w/ slower Q-sensitive preamps:
  rate not issue in H-jet; Q-sensitive lower noise
- If budget allows:
  - replace 1 pair det. w/ Hamamatsu single ch./strip photo-diode
  - better E-resolution, allow lower E-threshold
  - lower E $\rightarrow$ lower $|t|$ $\rightarrow$ higher rate, statistics

Run 12 (pC): α-sources, t_0 scint.

- Detected ^{12}C 0.4-0.9 keV range 1-2μ in Si det. (dead layer ~¼μ)
- ^{241}Am α 5.45 MeV range ~25μ in Si; little sensitivity to ^{12}C region
- Add new sources: ^{148}Gd 3.18 MeV α range ~12μ in Si; closer to ^{12}C
- Also: may try degrading α energies with foils to probe ^{12}C region
- H-jet: add 2nd Gd source to side currently w/o
- Prompt scintillators in Y2Up pol. → new data, still exploring
- Already shown: check/constrain t_0
- May help further use of TOF info, e.g. alternative to energy cuts
- Need e.g. beam t-RMS, monitored:
- Will install prompt scintillators in all 4 pC polarimeters

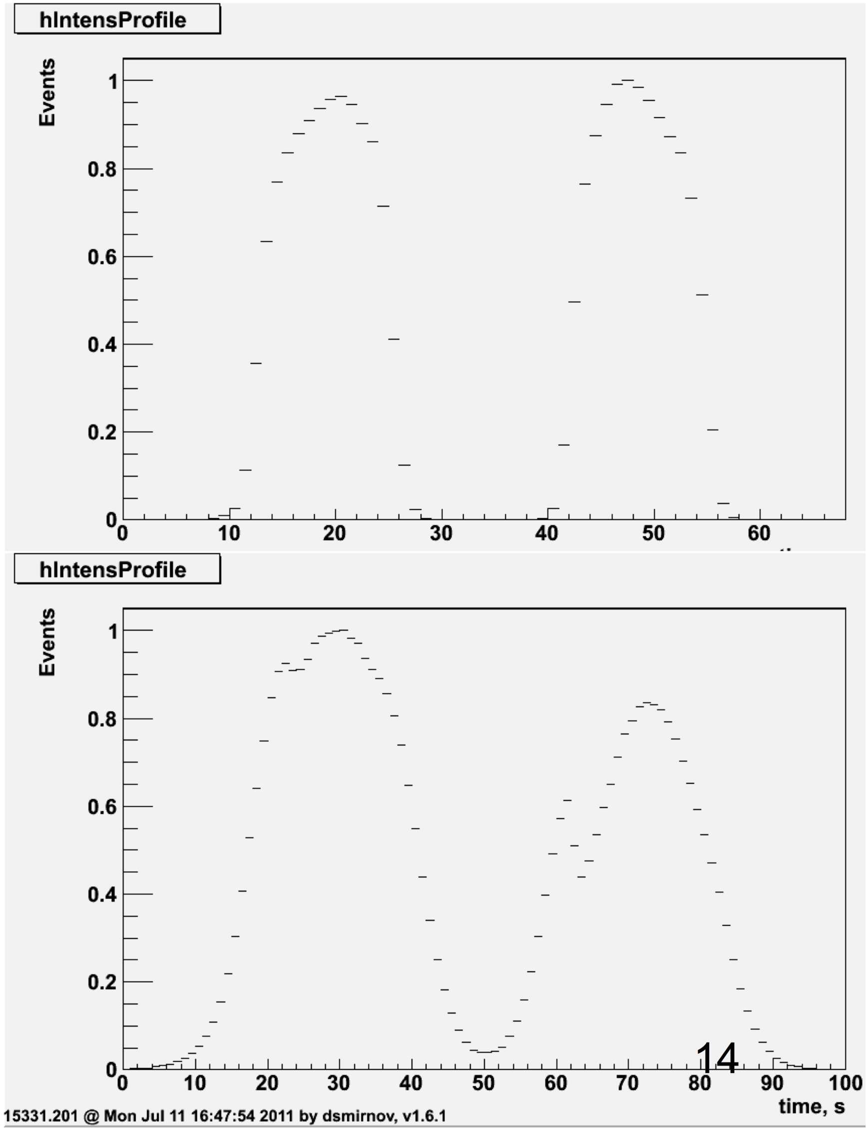


Run12 preparations/plans: C targets

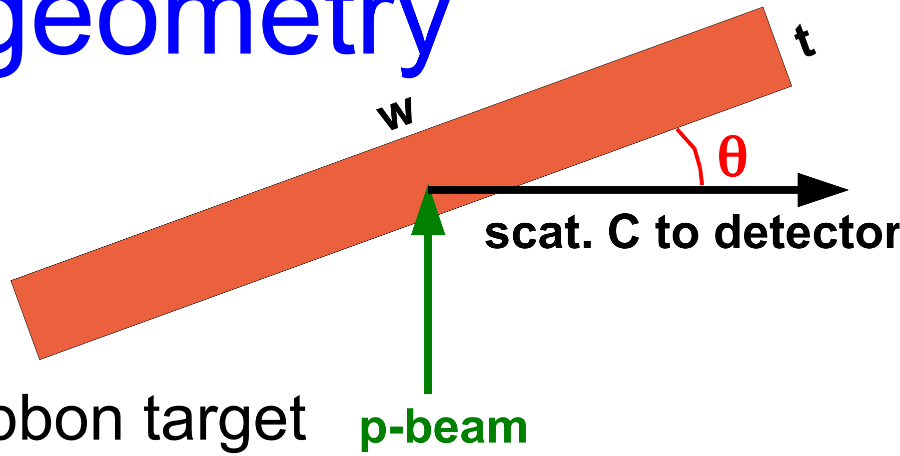
- Outstanding question on target mortality:
  - Are targets killed by exposure to beam?
  - Or is it step. motor motion, vibration, etc.?
- Started this week: target stress tests
  - rotate target ladders in/out beam ~1000 times
  - visually inspect survival every ~100 cycles
- If motor motion is fatal, may identify problem

<u>Already observed:</u>

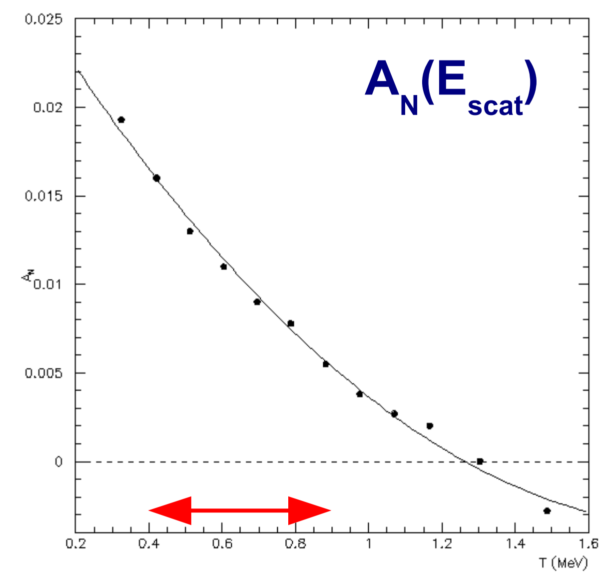
- Looser, thicker targets survive better
- Tempting to act on this, but:
- Loose targets don't give faithful profiles:
  - horiz. axis $\propto$ step. motor position
  - step. motor position $\neq$ target position
- And loose targets also problem for polarization measurement stability ↘

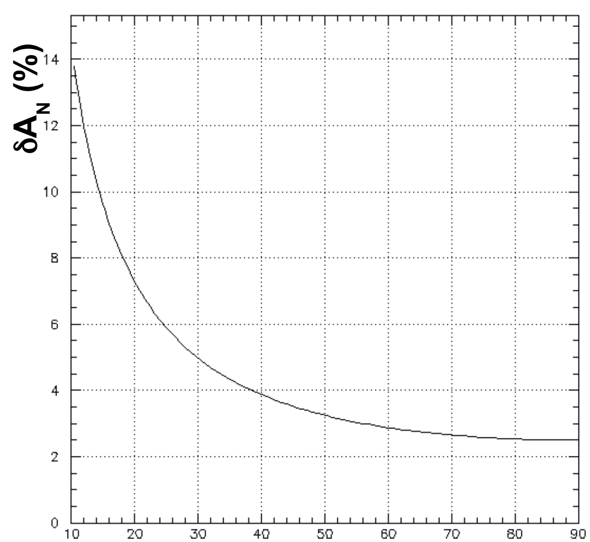


Ribbon target geometry



- Top view of vertical ribbon target, width w≈7μ, thickness t≈25nm:
- Scattered ^{12}C nuclei lose energy in ^{12}C ribbon target en route to Si detectors
- Measured E_{meas} down-shifted from scattered E_{scat}
- If θ changes path length changes
  given E_{meas} corresponds to different E_{scat}, A_N:
- $L \propto t/\sin(\theta) \Rightarrow$ steep change A_N as $\rightarrow 0°$

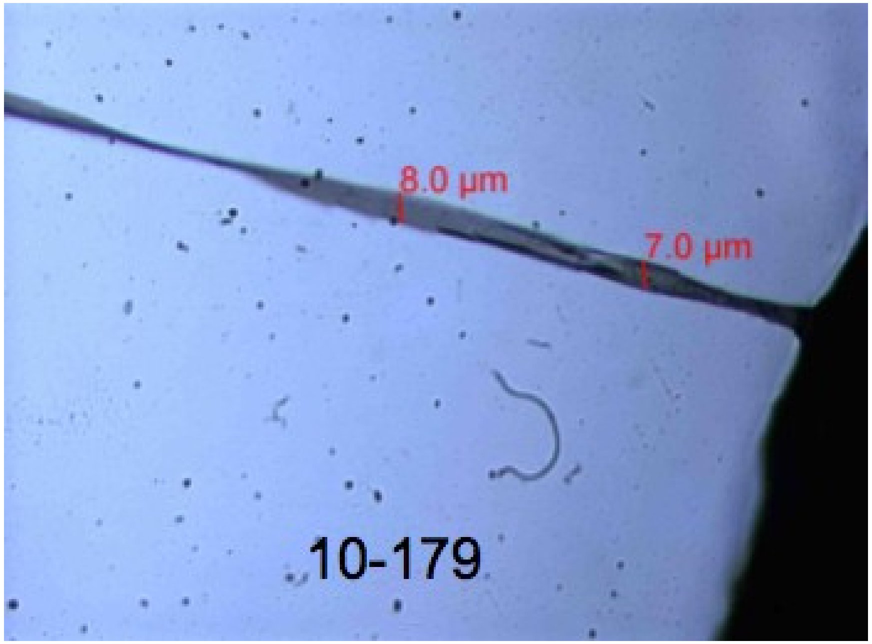




Loose targets ⇒ unstable orientation
⇒ unstable effective A_N

Run12 preparations/plans: C targets

- Even tight ribbons little control over θ
- Ribbons often twisted after mounted:
  try untwisting $\Rightarrow$ broken
- Length scale of twists $\approx$ 150 μ
- A few crossings of $\theta = 0°$ divergence
  across beam 0.5-1 mm



So the choice is:

- Loose ribbons, robust, but unstable measurements
- Tight ribbons, stable measurements, but short-lived

Probably choose: many poor measurements (over all Run12)
over: few good measurements (start Run12 until all lost)

- Longer term: consider alternatives to ribbon geometry...

Run 12 plans: general

H-jet: Standard maintenance &

- New dissociator stage: alleviate lower intensity Run11, requiring more maint. breaks; components in hand, assemble, test
- Running: monitor beam angle (BPMs), det. strip ↔ θ_{scat} correspondence

pC:

- Unify online↔offline analyses (e.g. use same A_N) ⇒ reduce confusion
- Operationally: - work w/ controls group, get system more friendly
  - we only use pC sweep runs for polar., can minimize fixed target runs (1 end of fill)
- w/o rate problems in Run11 were able to see smaller glitches
  ⇒ developing new QA to catch these

H-jet & pC: 100 GeV bonus

- 5 weeks @ 100 GeV ⇒ pC A_N @ 100 GeV (for present detectors, electronics)
- With injection run (end Run11) and full Runs11,12
  ⇒ pC A_N @ 24,100,250 GeV
- Improved study P-loss through ramp cycle

Longer term prospects

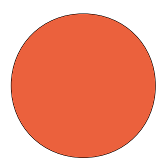
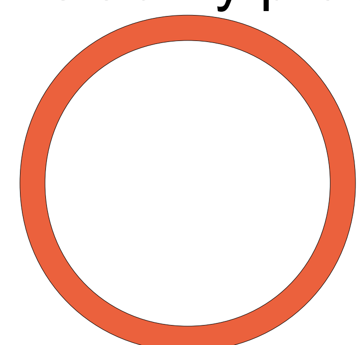
<u>H-jet detectors:</u>

- Increased detector area → statistics; new det. development

<u>pC detectors:</u>

- Migrate BNL → commercial (Hamamatsu) detectors (cost, availability)

<u>pC targets:</u>

- Circularly symmetric targets would avoid orientation stability problem
- e.g. carbon wire:  or a carbon tube: 
- Starting to look like nanotubes
- To set the scale, present ribbons ~115 C atoms thick
- Need to explore alternate technologies, geometries...

Summary

few points to take home:

- pC rate problems (Run9 & earlier)
  are ~gone, remainder manageable

- Present Si detectors (H-jet &pC) are adequate
  for rates, doses so far

- Target orientation instability may be limiting
  factor in polar. measurement stability

- pC targets trade stability → lifetime
  need to explore alternatives longer term